TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	09/823,429
Filing Date	March 30, 2001
First Named Inventor	Sanjay K. Agrawal
Art Unit	2151
Examiner Name	Karen C. Tang
Attorney Docket Number	CISCP539

Total Number of Pages in This Submission | 39

ENCLOSURES   *(Check all that apply)*

☑ Fee Transmittal Form

☑ Fee Attached

☐ Amendment/Reply

☐ After Final

☐ Affidavits/declaration(s)

☐ Extension of Time Request

☐ Express Abandonment Request

☐ Information Disclosure Statement

☐ Certified Copy of Priority Document(s)

☐ Reply to Missing Parts/ Incomplete Application

☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53

☐ Drawing(s)

☐ Licensing-related Papers

☐ Petition

☐ Petition to Convert to a Provisional Application

☐ Power of Attorney, Revocation Change of Correspondence Address

☐ Terminal Disclaimer

☐ Request for Refund

☐ CD, Number of CD(s) _____

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☐ After Allowance Communication to TC

☐ Appeal Communication to Board of Appeals and Interferences

☑ Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**

☐ Proprietary Information

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☑ Other Enclosure(s) (please Identify below):

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Remarks

The Commissioner is authorized to charge any additional fees to Deposit Account 50-1652.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

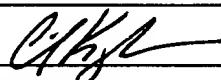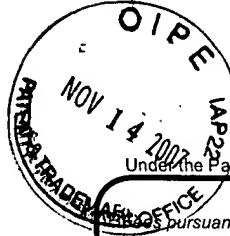|	
Firm Name	Cindy S. Kaplan, Attorney at Law
Signature	
Printed name	Cindy S. Kaplan
Date	November 12, 2007
Reg. No.	40,043

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Signature			
Typed or printed name	Cindy S. Kaplan	Date	November 12, 2007

FEE TRANSMITTAL
For FY 2008

Effective on 12/08/2004.
pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

Complete if Known	
Application Number	09/823,429
Filing Date	March 30, 2001
First Named Inventor	Sanjay K. Agrawal
Examiner Name	Karen C. Tang
Art Unit	2151
Attorney Docket No.	CISCP539

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($)	510

METHOD OF PAYMENT (check all that apply)

✔ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

✔ Deposit Account   Deposit Account Number: 50-1652   Deposit Account Name: Cindy Kaplan

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	Small Entity Fee ($)	SEARCH FEES Fee ($)	Small Entity Fee ($)	EXAMINATION FEES Fee ($)	Small Entity Fee ($)	Fees Paid ($)
Utility	310	155	510	255	210	105	_____
Design	210	105	100	50	130	65	_____
Plant	210	105	310	155	160	80	_____
Reissue	310	155	510	255	620	310	_____
Provisional	210	105	0	0	0	0	_____

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	210	105
Multiple dependent claims	370	185

Total Claims		Extra Claims	Fee ($)	Fee Paid ($)
_____	- 20 or HP =	_____ x	50 =	_____

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims	Fee ($)	Fee Paid ($)
_____	- 3 or HP =	_____ x	210 =	_____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims

Fee ($)	Fee Paid ($)
_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $260 ($130 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets	Number of each additional 50 or fraction thereof		Fee ($)	Fee Paid ($)
_____	- 100 =	_____	/ 50 = _____	(round up to a whole number) x	_____ =	_____

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	_____
Other (e.g., late filing surcharge): Filing a brief in support of an appeal	510

SUBMITTED BY

Signature	*[signature]*	Registration No. (Attorney/Agent)	40,043	Telephone	408-399-5608
Name (Print/Type)	Cindy S. Kaplan			Date	November 12, 2007

EX PARTE SANJAY K. AGRAWAL

Application for Patent

Filed March 30, 2001

U.S. Patent Application No. 09/823,429

Examiner: Karen C. Tang

Art Unit: 2151

FOR:

METHOD AND APPARATUS FOR ESTIMATING PERIODIC WORST-CASE DELAY UNDER ACTUAL AND HYPOTHETICAL CONDITIONS USING A MEASUREMENT BASED TRAFFIC PROFILE

APPEAL BRIEF
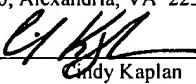
11/15/2007 HVUDN61 00000009 09823429

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TABLE OF CONTENTS

This is an appeal from the final rejection in the Office action dated May 18, 2007. The Notice of Appeal was filed on September 18, 2007.

I.   REAL PARTY IN INTEREST

The real party in interest is Cisco Technology, Inc., the assignee of the present application.

II.   RELATED APPEALS AND INTERFERENCES

There are currently no known appeals or interferences which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III.   STATUS OF THE CLAIMS

There have been a total of 47 claims presented throughout the prosecution of this application. Claims 1, 4, 8, 9, 11, 14, 19, 20, 22, 23, 25, 27, 29, 31, and 33-47 have been rejected under 35 U.S.C. §103(a). Claims 2, 3, 5-7, 10, 12, 13, 15-18, 21, 24, 26, 28, 30, and 32 have been canceled. A copy of the claims on appeal is attached hereto as Claims Appendix.

IV. STATUS OF AMENDMENTS

No amendments have been filed subsequent to the final Office action of May 18, 2007.

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V. SUMMARY OF CLAIMED SUBJECT MATTER

The claims relate generally to a method and apparatus for estimating worst-case delay for a traffic aggregate.

Traffic aggregate refers to a class or label on which traffic is classified and queued. The traffic aggregate has an associated bandwidth (rate), which may be a maximum average bandwidth that has been agreed upon by a customer and service provider (e.g., in a Service Level Agreement (SLA)). (Specification, page 7, line 13 – page 8, line 5).

The provider typically polices customer traffic and traffic that exceeds the SLA is dropped, reclassified, or otherwise dealt with in accordance with the SLA. After policing, traffic is queued and sent out of the apparatus (e.g., router) on an output link. The output link has an associated bandwidth referred to as an output link bandwidth. Multiple queues can share an output link, with each queue allotted a share of the output link bandwidth. (Specification, page 8, lines 6–14). The allocated output link bandwidth is greater than or equal to the associated rate of traffic to prevent the queue from overflowing. (Specification page 18, line 8-11).

Referring to Fig. 1, traffic from customers A, B, and C arrives at a router and each traffic stream is policed according to the applicable SLA by policers 10, 11, and 12. After policing, each of the traffic streams has been constrained so that it does not exceed the bandwidth specified in the SLA. The traffic streams are sent to queue 120 and packets are scheduled and sent out of the queue. Queue 120 is coupled to an output link having a link capacity apportioned among the various queues associated with the output link. (Specification, page 9, lines 3–18).

A periodic worst case delay is calculated for a traffic aggregate, such as Customer A. The traffic is monitored and the arrival time and packet size of each packet arriving at the corresponding queue is recorded over an interval of time. A rate-burst traffic profile is calculated. The profile includes a rate parameter r and a burst parameter b. The value of the rate parameter is set to the associated rate (e.g., negotiated rate) for the traffic. The burst parameter is calculated based on the associated rate. A periodic worst-case delay is calculated by dividing the burst

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parameter by the allocated bandwidth. (Specification page 9, line 19 – page 10, line 11).

In one embodiment, the effect of a change in bandwidth allocation by the provider can be calculated for a set of traffic data. A predicted worst-case delay is calculated by dividing the burst parameter (based on the associated rate) by a hypothetical bandwidth allocation. A service provider can use this value to determine how much additional bandwidth to allocate to a class to achieve a desired decrease in delay. In another embodiment, the rate parameter can be set to a hypothetical negotiated rate and similar calculations performed. (Specification, page 11, lines 10-17, page 20, lines 7-16, Fig. 11).

The periodic worst-case delay at each node in a network can be calculated as previously described, and the periodic worst-case delay at each node in a path can be added together to calculate a periodic worst-case delay for the path. (Specification, page 11, lines 6-9, page 19, line 16–page 20, line 2, Fig. 10).

Figure 8 illustrates a plot including a burst-rate profile, having y-intercept b and slope r, referred to by reference number 820. A cumulative bandwidth line 810 has a slope equal to the allocated bandwidth for the queue (the portion of the total link capacity allotted to the queue), and y-intercept 0. Line 810 represents the total amount of traffic that can be sent over the output link from a given class queue for a given customer versus time. (Specification, page 18, lines 4-8, Fig. 8).

An error of data from the burst-rate traffic profile may be calculated. If the error is unacceptable, a new burst parameter is calculated from previously collected data or a new set of data. In this manner, the burst parameter only needs to be recalculated when the current burst and rate parameters fail to fit the current traffic profile. (Specification, page 19, lines 6-14, Fig. 9).

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VI.   GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

In the final Office Action dated May 18, 2007, the Examiner rejects claims 1, 4, 8, 9, 11, 14, 19, 20, 22, 23, 25, 27, 29, 31, and 33-47 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Publication No. 2002/0097726 (Garcia-Luna-Aceves et al.) in view of U.S. Patent Application Publication No. 2002/0073224 (Varma et al.).

Accordingly, the issue on appeal is:

Whether claims 1, 4, 8, 9, 11, 14, 19, 20, 22, 23, 25, 27, 29, 31, and 33-47 are unpatentable under 35 U.S.C. 103 over Garcia-Luna-Aceves et al. in view of Varma et al.

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VII. ARGUMENT

A. Rejection Under 35 U.S.C. 103(a) over U.S. Patent Application Publication Nos. 2002/0097726 (Garcia-Luna-Aceves et al.) and 2002/0073224 (Varma et al.)

(1) Claims 1, 8, 14, 19, 23, 33, 34, 35, 38, 39, 42, 43, and 47 are Patentable Over Garcia-Luna-Aceves et al. and Varma et al.

Claim 1 is directed to a method and claims 14 and 23 are directed to an apparatus for estimating periodic worst-cast delay for a traffic aggregate having an associated rate. The method includes, inter alia, collecting traffic data at a queue, calculating a burst-rate traffic profile responsive to the collected traffic data and the associated rate, and calculating a periodic worst-case delay by dividing the burst parameter by a share of output link bandwidth allotted to the queue.

As described in the specification, the associated rate is a specified bandwidth, which may be, for example, a negotiated rate agreed to by a customer sending traffic data. Claims 1, 14, and 23 specify that the associated rate is a specified bandwidth for the traffic aggregate. The associated rate is used to calculate the burst-rate traffic profile and a burst parameter. After traffic is queued, it is sent out of the router on an output link. The output link has an associated output link bandwidth. Multiple queues can share an output link, with each queue allotted a share of the output link bandwidth. Claims 1, 14, and 23 specify that the share of the output link bandwidth allotted to the queue is used to calculate the periodic worst-case delay.

Appellant submits that the references cited, whether considered separately or taken as a whole, do not teach or suggest the claimed subject matter. The elements of claim 1, including collecting traffic data, calculating a burst-rate traffic profile, and calculating a periodic worst-cast delay, are each discussed in detail below.

The cited references do not show or suggest collecting traffic data at a queue associated with a traffic aggregate over a time interval, the traffic data comprising

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packet size and arrival time of each packet arriving at the queue during the time interval, as set forth in claim 1.

Garcia-Luan-Aceves et al. disclose a method for maintaining reservation state in a network router. Appellant notes that Garcia-Luna-Aceves et al. was filed after the filing date of Appellant's invention and that only the subject matter contained in related provisional application No. 60/240,654, filed October 10, 2000 is prior art.

The Examiner cites paragraphs [0016], [0054], [0066], and [0089] of Garcia-Luan-Aceves et al. with respect to collecting traffic comprising packet size and arrival time over a time interval. As noted at paragraph [0054], routers only know the rates of incoming traffic on the links and the rates of outgoing traffic for each destination, they do not maintain information on the rates of each flow. Paragraph [0016] notes that the invention provides techniques that replace per-flow state and per-flow processing with mechanisms whose complexity is determined by the network parameters. Paragraph [0066] refers to how classes are based on packet sizes. A shaper is used to shape flows to a form (L, ρ), where L is the maximum size of any packet of the flow and ρ is the rate of the flow. Paragraph [0089] describes classes based on burst-drain-times, which is the time to transmit one bucket at the rate of the flow. The Examiner has failed to point to any teaching of collecting traffic data at a queue of a router, the queue associated with a traffic aggregate over a time interval, and the traffic data comprising packet size and arrival time of each packet arriving at the queue during the time interval, as required by claim 1. Appellant further notes that at page 6 of the final Office Action dated May 18, 2007, the Examiner states that Garcia-Luan-Aceves et al. do not expressly indicate that the arrival time of traffic is collected.

Varma et al. describe a method for determining burstiness of a traffic source. The Examiner cites paragraph [0067] of Varma et al. with regard to collected traffic data. Paragraph [0067] describes how active periods are determined by traversing a sequence of frames and computing the queue size after each frame arrives. Varma et al. do not collect packet size and arrival time for each packet. In contrast, Varma et al. compute a queue size at certain periods to determine active periods of a stream.

The cited references also do not show or suggest calculating a burst-rate traffic profile responsive to traffic data collected at a queue over a time interval and a

specified bandwidth and calculating a burst parameter based on the specified bandwidth, as set forth in claim 1.

With regard to calculating a burst-rate traffic profile responsive to the traffic data collected and the specified bandwidth, the Examiner cites paragraph [0063] of Garcia-Luan-Aceves et al. This section of the Garcia-Luan-Aceves et al. patent application defines a delay for the flow as the waiting time at the shaper at the ingress node and the propagation delays of the links on the flow's path (see equation in paragraph [0063]). The equation in paragraph [0063] includes a maximum burst size σ (not a burst parameter calculated based on a specified bandwidth for the traffic aggregate, as required by claim 1) divided by an average rate of flow ρ of incoming traffic (rather than a specified bandwidth for a traffic aggregate, as set forth in the claims).

Furthermore, the cited references do not show or suggest calculating a periodic worst-case delay for a burst-rate profile by dividing a burst parameter by a share of output link bandwidth allotted to a queue, wherein the share of output link bandwidth is greater than or equal to the associated rate, as set forth in claim 1.

The Examiner cites the same equation and parameters from Garcia-Luan-Aceves et al. for calculating a periodic worst-cast delay as were cited for calculating a burst-rate traffic profile (paragraph [0063]). Garcia-Luan-Aceves et al. simply show a flow delay calculated using a maximum burst size of flow of incoming traffic divided by the average rate of flow of the incoming traffic (see, paragraphs [0054], [0063], and Fig. 1). Thus, there is no burst parameter calculated based on a specified bandwidth (Garcia-Luan-Aceves et al. instead use a maximum burst size as the burst parameter), divided by a share of output link bandwidth allotted to a queue (Garcia-Luan-Aceves et al. use an average rate of flow of incoming traffic). The average rate of flow used by Garcia-Luan-Aceves et al. in a delay calculation masks extreme high values (e.g., occasional large delays), which can be very annoying to a typical user.

Appellant also notes that on the bottom of page 6 of the final Office Action dated May 18, 2007, the Examiner states that Garcia-Luan-Aceves et al. do not expressly indicate calculating a periodic worst-case delay for the burst-rate traffic

profile by dividing a burst parameter by an allocated bandwidth associated with the queue.

The Examiner cites paragraph [0015] of Varma et al. with regard to calculating a delay. Paragraph [0015] describes a latency rate model in which the worst case delay is determined by dividing the queue size by the average source rate and adding the latency at each scheduler (see, also paragraphs [0010]-[0013]). Varma et al. do not teach calculating a periodic worst-case delay by dividing a burst parameter calculated based on a specified bandwidth for a traffic aggregate at a queue, by a share of output link bandwidth allotted to the queue, as set forth in the claims. In contrast to Appellant's invention, Varma et al. divide a queue size by an average source rate at a server. As noted above, averaging rate of flow masks extreme high values (e.g., occasional large delays). Claim 1 specifically recites calculations which use both a share of output link bandwidth allotted to a queue and an associated rate (specified bandwidth), which are two distinct values. The equations cited by the Examiner in both references use only an average rate of flow of incoming traffic. Moreover, neither reference shows or suggests a share of output link bandwidth that is used to calculate a worst-case delay and is greater than or equal to an associated rate (specified for a traffic aggregate and used in calculating a burst parameter).

In the Response to Arguments in the final Office Action dated May 18, 2007, the Examiner provides the following:

> "[I]t is being interpret[ed] that the worst case is calculated by dividing the burst parameter by a bandwidth that is assigned/allocated to the queue, and the bandwidth which is greater or equal to the associated rate, which [ ] still reads on [ ] Varma's references. Further Garcia disclosed wherein the queue is allotted a share of an output link capacity, said share exceeding the associated rate (refer to 0106 or 0057)."

The Examiner refers to paragraphs [0106] and [0057] of Garcia-Luan-Aceves et al. as disclosing that a queue is allotted a share of an output link capacity. These paragraphs simply describe how extra bandwidth can be allocated on a per-class basis and that a link scheduler maintains only the total allocated bandwidth for real time

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flows on a link. Claim 1, however, requires that a periodic worst-case delay is calculated by dividing a burst parameter by a share of output link bandwidth allotted to a queue. After traffic is queued, it is sent out of the router on an output link. The output link has as associated output link bandwidth. Multiple queues can share an output link, with each queue allotted a share of the output link bandwidth. It is this share of the output link bandwidth that is used to calculate the worst-case delay. Garcia-Luan-Aceves et al. do not use a share of output link bandwidth in a delay calculation.

The cited references provide information only about current conditions. They do not predict how the system will perform under different traffic conditions or with a different allocation of resources (e.g., change in specified bandwidth or change in share of output link bandwidth allotted to a queue). Appellant's invention, as set forth in the claims, is particularly advantageous in that it allows for the worst-case delay to be analyzed under hypothetical conditions such as different output link bandwidth allocations. The method and apparatus can be used to estimate the effect of an increase in bursty traffic on delay and can be used to tell how much additional bandwidth is needed to achieve a certain reduction in delay with existing traffic. For example, a service provider can use the calculated worst-case delay to determine how much additional bandwidth to allocate to a queue to achieve a desired decrease in delay. In another example, the associated rate can be set to a hypothetical negotiated rate and similar calculations performed. The claimed method and apparatus thus provide decoupling of traffic measurements from resource allocation. This allows bandwidth and delay trade off to be easily observable. Also, delay performance can be estimated for present and future traffic.

Accordingly, it is respectfully submitted that the rejection of claims 1, 14, and 23 based on Garcia-Luan-Aceves et al. and Varma et al. should be withdrawn and these claims allowed.

Claims 8, 33, 34, 35, 38, and 39, depending either directly or indirectly from claim 1, claims 19, 42, and 43, depending directly or indirectly from claim 14, and claim 47, depending directly from claim 23, are submitted as patentable for at least the same reasons as claim 1, 14, and 23.

(2) **Claim 4 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.**

Claim 4 depends directly from independent claim 1 and is further submitted as patentable because none of the cited references teaches using a negotiated rate agreed to by a customer sending the traffic data to calculate a burst parameter used in calculating a periodic-worst case delay. As discussed above, both Garcia-Luna-Aceves et al. and Varma et al. use an average rate of incoming flow to calculate a delay. In rejecting claim 4, the Examiner cites paragraph [0053] of the Garcia-Luna-Aceves et al. patent application. This paragraph describes token-bucket parameters for input flow, which include a maximum burst size and an average rate of flow. There is no teaching of using a negotiated rate agreed to by a customer sending traffic data in any type of delay calculation.

Accordingly, it is submitted that the pending rejection of claim 4 should be reversed for this additional reason.

(3) **Claim 36 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.**

Claim 36 depends directly from independent claim 1 and is further submitted as patentable because none of the cited references teaches using a negotiated rate for a specified class of traffic to calculate a burst parameter used in calculating a periodic-worst case delay. As discussed above, both Garcia-Luna-Aceves et al. and Varma et al. use an average rate of incoming flow to calculate a delay. In rejecting claim 36, the Examiner cites paragraphs [0053] and [0068] of the Garcia-Luna-Aceves et al. patent application. Paragraph [0053] describes token-bucket parameters for input flow, which include a maximum burst size and an average rate of flow. Paragraph [0068] describes how only flows that belong to the same class are merged and the link schedulers process flows that belong to one of the classes. There is no teaching of using a negotiated rate for a specified class of traffic.

Accordingly, it is submitted that the pending rejection of claim 36 should be reversed for this additional reason.

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(4) <u>Claim 37 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.</u>

Claim 37 depends directly from independent claim 1 and is further submitted as patentable because none of the cited references teaches using an associated rate that is a maximum average bandwidth specified in a service level agreement to calculate a burst parameter used in calculating a periodic-worst case delay. As discussed above, both Garcia-Luna-Aceves et al. and Varma et al. use an average rate of incoming flow to calculate a delay. In rejecting claim 37, the Examiner cites paragraph [0053] of the Garcia-Luna-Aceves et al. patent application. This paragraph describes token-bucket parameters for input flow, which include a maximum burst size and an average rate of flow. There is no teaching of using a maximum average bandwidth specified in a service level agreement in any type of delay calculation.

Accordingly, it is submitted that the pending rejection of claim 37 be reversed for this additional reason.

(5) <u>Claim 40 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.</u>

Claim 40 depends directly from claim 1 and is further submitted as patentable over the cited references which do not show or suggest calculating error of data by comparing collected data to a burst-rate traffic profile. In rejecting these claims the Examiner refers to paragraph [0089] of the Garcia-Luna-Aceves et al. patent application. This paragraph describes how flows with the same burst-drain-times can be merged without changing the burst-drain-time of the resulting flows. There is no discussion of calculating error of data or comparing collected data to a burst-rate traffic profile.

Accordingly, it is submitted that the pending rejection of claim 40 should be reversed for this additional reason.

(6) <u>Claim 41 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.</u>

Claim 41 depends directly from claim 40 and is submitted as patentable for at least the same reasons as claim 40.

Furthermore, claim 41 is submitted as patentable because none of the cited references show or suggest calculating a new burst parameter if an error of data is higher than a predetermined limit, as set forth in claim 41. Applicant's claimed invention provides a burst parameter that only needs to be recalculated when the burst parameter fails to fit a current traffic profile.

Accordingly, it is submitted that the pending rejection of claim 41 should be reversed for this additional reason.

(7) <u>Claims 9, 20, 22, 25, 29, and 44 are Patentable Over Garcia-Luna-Aceves et al. and Varma et al.</u>

Claim 9 is directed to a method, claims 20 and 25 are directed to an apparatus, and claim 29 is directed to a computer program product for estimating worst-case queuing delay along a path. The method includes collecting a rate parameter and a burst parameter, calculating a periodic worst-case delay associated with the rate and burst parameters for each router in the path, and adding up the calculated periodic worst-case delay associated with the routers along the path.

As previously discussed with regard to claim 1, neither Garcia-Luna-Aceves et al. nor Varma et al. show or suggest calculating a periodic worst-case delay, as set forth in the claims. In particular, the cited references do not show or suggest periodically collecting a rate parameter and a burst parameter, wherein the burst parameter is calculated based on a specified bandwidth. Garcia-Luan-Aceves et al. use a maximum burst size rather than a burst parameter calculated based on a specified bandwidth. Also, rather than calculating a periodic worst-case delay by dividing the burst parameter (based on a specified bandwidth) by a share of output link bandwidth allotted to the queue, the cited references use an average flow rate to calculate a delay. (See above arguments with respect to claim 1).

Moreover, the cited references do not teach adding up a periodic worst-case delay associated with routers along a path, as required by claim 9. The Examiner refers to parameter T_{ik} of Garcia-Luan-Aceves et al. with respect to this limitation. Parameter T_{ik} is the propagation delay of a link (i, k). This is added to the waiting time at the shaper at the ingress node. Garcia-Luna-Aceves et al. do not add up calculated worst-case delays associated with routers along a path. Instead Garcia-Luna-Aceves et al. add propagation delay of a link to a calculated waiting time at a shaper at an ingress node (see paragraph [0063]).

Accordingly, it is respectfully submitted that the rejection of claims 9, 20, 25, and 29 based on Garcia-Luan-Aceves et al. and Varma et al. should be withdrawn and these claims allowed.

Claim 22, depending directly from claim 20 and claim 44, depending directly from claim 9, are submitted as patentable for at least the same reasons as claims 20 and 9.

(8) Claim 45 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.

Claim 45 depends directly from independent claim 9 and is further submitted as patentable because none of the cited references teaches using a rate agreed to by a customer sending the traffic data to calculate a burst parameter used in calculating a periodic-worst case delay. As discussed above, both Garcia-Luna-Aceves et al. and Varma et al. use an average rate of incoming flow to calculate a delay. The Examiner has failed to point to any teaching of using a rate agreed to by a customer sending traffic data in a delay calculation.

Accordingly, it is submitted that the pending rejection of claim 45 should be reversed for this additional reason.

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(9) Claim 11 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.

Claim 11 is directed to a method of estimating periodic-worst case queuing delay for a class of traffic at a router, the class of traffic having a negotiated rate. The method includes receiving packets at an input interface of a router, sending each packet to one of a plurality of streams responsive to a customer identification, and sending each packet in at least one of the streams to one of a plurality of queues responsive to a class field. The method further includes monitoring an arrival time and size of each packet during an interval of time, calculating a burst-parameter based on the negotiated rate, and a burst-rate traffic profile responsive to the arrival time and size of each packet and the negotiated rate. A periodic worst-case delay for the burst-rate traffic profile is calculated by dividing the burst parameter by an output link capacity allotted to the queue corresponding to the class of traffic.

As previously discussed, the cited references do not show or suggest monitoring an arrival time and size of each packet on a queue during an interval of time. The Examiner states in the final Office Action dated May 18, 2007 that Garcia-Luan-Aceves et al. do not expressly indicate that the arrival time of traffic is collected. Rather than monitoring arrival time and size for each packet, Varma et al. compute a queue size at certain periods to determine active periods of a stream.

Furthermore, the cited references do not calculate a burst parameter based on a negotiated rate. As previously discussed, Garcia-Luan-Aceves et al. use a maximum burst size and do not calculate a burst parameter based on a specified parameter, such as a negotiated rate.

Moreover, neither Garcia-Luan-Aceves et al. nor Varma et al., either alone or in combination, show or suggest calculating a periodic worst-case delay for a burst-rate traffic profile by dividing a burst parameter by an output link capacity allotted to the queue corresponding to a class of traffic. The Examiner states in the final Office Action that Garcia-Luan-Aceves et al. do not expressly indicate calculating a periodic worst-case delay, as set forth in the claims. In contrast to Appellant's claimed invention, Varma et al. divide a queue size by an average source rate at a server. (See arguments above with respect to claim 1).

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Accordingly, it is respectfully submitted that the rejection of claim 11 based on Garcia-Luan-Aceves et al. and Varma et al. should be withdrawn and claim 11 allowed.

(10) <u>Claim 46 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.</u>

Claim 46 depends directly from claim 11 and is further submitted as patentable over the cited references which do not show or suggest calculating error of data by comparing collected data to a burst-rate traffic profile. In rejecting these claims the Examiner refers to paragraph [0089] of the Garcia-Luna-Aceves et al. patent. This paragraph describes how flows with the same burst-drain-times can be merged without changing the burst-drain-time of the resulting flows. There is no discussion of calculating error of data or comparing collected data to a burst-rate traffic profile.

Accordingly, it is submitted that the pending rejection of claim 46 should be reversed for this additional reason.

(11) <u>Claim 27 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.</u>

Claim 27 is directed to a computer program product for estimating periodic-worst case delay in a packet switched network and is submitted as patentable for at least the reasons discussed above with respect to claim 1.

Claim 27 is further submitted as patentable because none of the cited references teaches calculating a burst-rate traffic profile responsive to collected traffic data and a negotiated rate. As previously discussed, both Garcia-Luna-Aceves et al. and Varma et al. use an average rate of incoming flow to calculate a delay. (See above argument with respect to claim 4).

Accordingly, it is respectfully submitted that the rejection of claim 27 based on Garcia-Luan-Aceves et al. and Varma et al. should be withdrawn and claim 27 allowed.

(12) Claim 31 is Patentable Over Garcia-Luna-Aceves et al. and Varma et al.

Claim 31 is directed to a method of estimating worst-case queuing delay along a path comprising routers. The method includes calculating periodic worst-case delay associated with a queue for each of the routers by dividing a burst parameter by a share of output link bandwidth allotted to the queue, periodically collecting periodic worst-case-delay from each of the routers, and adding up the calculated periodic worst-case delay associated with the routers.

As previously discussed, the cited references do not show or suggest calculating a worst-case delay associated with a queue by dividing a burst parameter by a share of output link bandwidth allotted to the queue. (See above arguments with respect to claim 1).

Moreover, the cited references do not teach adding up a calculated periodic worst-case delay associated with routers along a path, as required by claim 31. The Examiner refers to parameter T_{ik} of Garcia-Luan-Aceves et al. with respect to this limitation. Parameter T_{ik} is the propagation delay of a link (i, k). This is added to the waiting time at a shaper at an ingress node. Garcia-Luna-Aceves et al. do not add up calculated worst-case delays associated with routers along a path. Instead Garcia-Luna-Aceves et al. add propagation delay of a link to a calculated waiting time at a shaper at an ingress node (see paragraph [0063]).

Accordingly, it is respectfully submitted that the rejection of claim 31 based on Garcia-Luan-Aceves et al. and Varma et al. should be withdrawn and these claims allowed.

B. Conclusion

In view of the foregoing, it is respectfully submitted that the pending claims are patentable over Garcia-Luna-Aceves et al. and Varma et al. Accordingly, the pending

rejections of all of the claims under 35 U.S.C. §103(a) should be reversed and these claims allowed.

Respectfully Submitted,

[signature]

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VIII. CLAIMS APPENDIX

1. In a packet switched computer network, a method of estimating periodic worst-case delay for a traffic aggregate having an associated rate, the method comprising:

collecting traffic data at a queue of a router, said queue associated with the traffic aggregate over a time interval, the traffic data comprising packet size and arrival time of each packet arriving at the queue during the time interval;

calculating a burst-rate traffic profile responsive to the traffic data collected at said queue over said time interval and the associated rate, wherein the associated rate is a specified bandwidth for the traffic aggregate and calculating the burst-rate traffic profile comprises calculating a burst parameter based on the associated rate; and

calculating a periodic worst-case delay for the burst-rate traffic profile by dividing the burst parameter by a share of output link bandwidth allotted to said queue, wherein the share of output link bandwidth is greater than or equal to the associated rate.

4. A method as in claim 1 wherein the associated rate is a negotiated rate agreed to by a customer sending the traffic data.

8. A method as in claim 1 wherein the traffic aggregate is a class of traffic.

9. In a packet switched network, a method of estimating worst-case queuing delay along a path, said path comprising routers, the method comprising:

periodically collecting a rate parameter and a burst parameter associated with a queue for each of a plurality of routers, the burst parameter calculated based on a specified bandwidth;

calculating a periodic worst-case delay associated with the rate and burst parameters for said each of a plurality of routers, wherein calculating a periodic worst-case delay comprises dividing the burst parameter by a share of output link bandwidth allotted to the queue, wherein the share of output link bandwidth is greater than or equal to the specified bandwidth; and

adding up the calculated periodic worst-case delay associated with the routers along the path.

11. In a packet switched network, a method of estimating periodic worst-case queuing delay for a class of traffic at a router, the class of traffic having a negotiated rate, the method comprising:

receiving packets at an input interface of a router;

sending each packet to one of a plurality of streams responsive to a customer identification;

sending each packet in at least one of the plurality of streams to one of a plurality of queues responsive to a class field, each of said plurality of queues having an associated rate;

monitoring an arrival time and size of said each packet at the one of the plurality of queues during an interval of time;

calculating a burst parameter based on the negotiated rate;

calculating a burst-rate traffic profile responsive to the arrival time and size of said each packet and the negotiated rate; and

calculating a periodic worst-case delay for the burst-rate traffic profile by dividing the burst parameter by an output link capacity allotted to the queue corresponding to the class of traffic, the output link capacity greater than or equal to the associated rate.

14. In a packet switched network, an apparatus for estimating worst-case delay for a traffic aggregate having an associated rate, the apparatus comprising:

a monitor that collects traffic data comprising arrival time and size of packets arriving at a queue of a router, said queue associated with the traffic aggregate over a time interval;

a processor; and

a computer readable medium coupled to the processor and storing a computer program comprising:

code that causes the processor to receive the traffic data comprising packet size and arrival time of each packet arriving at the queue during the time interval;

code that causes the processor to calculate a burst-rate traffic profile responsive to the collected traffic data and the associated rate, wherein the associated rate is a specified bandwidth for the traffic aggregate and code that causes the processor to calculate a burst-rate traffic profile comprises code that causes the processor to calculate a burst parameter based on the associated rate; and

code that causes the processor to calculate a periodic worst-case delay for the traffic profile by dividing the burst parameter by a share of output link bandwidth allotted to the queue, wherein the share of output link bandwidth is greater than or equal to the associated rate.

19. An apparatus as in claim 14, wherein the computer readable medium is a CD-ROM, floppy disk, flash memory, system memory, or hard drive.

20. In a packet switched network, an apparatus for estimating periodic worst-case queuing delay along a path, said path comprising routers, the apparatus comprising:

a monitor agent that periodically collects traffic parameters associated with a queue for each of a plurality of routers;

a processor that can receive information from the monitor agent; and

a computer readable medium coupled to the processor and storing a computer program comprising:

code that causes the processor to receive burst and rate traffic parameters collected by the monitor agent;

code that causes the processor to calculate a delay associated with the traffic parameters for said each of a plurality of routers by dividing the burst parameter by a share of output link bandwidth allotted to the queue, wherein the share of output link bandwidth is greater than or equal to the specified bandwidth; and

code that causes the processor to add up the calculated periodic worst-case delay associated with the routers along the path.

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22. The apparatus of claim 20, wherein the computer readable medium is a CD-ROM, floppy disk, flash memory, system memory, or hard drive.

23. In a packet switched network, an apparatus for estimating periodic worst-case delay for a traffic aggregate having an associated rate, the apparatus comprising:

means for collecting traffic data comprising arrival time and size of packets arriving at a queue of a router, said queue associated with the traffic aggregate over a time interval, the traffic data comprising packet size and arrival time of each packet arriving at the queue during the time interval;

means for calculating a burst-rate traffic profile responsive to the collected traffic data and the associated rate, wherein the associated rate is a specified bandwidth for the network and means for calculating the burst-rate traffic profile comprises means for calculating a burst parameter based on the associated rate; and

means for calculating a periodic worst-case delay for the traffic profile by dividing the burst parameter by a share of output link bandwidth allotted to said queue, wherein the share of output link bandwidth is greater than or equal to the associated rate.

25. In a packet switched network, an apparatus for estimating periodic worst-case queuing delay along a path, said path comprising routers, the apparatus comprising:

means for periodically collecting rate and burst traffic parameters associated with a queue for each of a plurality of routers, the burst traffic parameter calculated based on a specified bandwidth;

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means for calculating a delay associated with the traffic parameters for said each of a plurality of routers by dividing the burst parameter by a share of output link bandwidth allotted to said queue, wherein the share of output link bandwidth is greater than or equal to the associated rate; and

means for adding up the calculated periodic worst-case delay associated with the routers along the path.

27. A computer program product for estimating periodic worst-case delay at a queue in a packet switched network, the computer program product comprising:

computer code that causes a processor to collect traffic data comprising arrival time and size of packets arriving at the queue of a router over a time interval, said traffic data having an associated negotiated rate;

computer code that causes a processor to calculate a burst traffic parameter for the collected traffic;

computer code that causes a processor to calculate a burst-rate traffic profile responsive to the collected traffic data and the associated negotiated rate;

computer code that causes a processor to calculate a periodic worst-case delay for the traffic profile by dividing the burst parameter by a share of output link bandwidth allotted to said queue, wherein the share of output link bandwidth is greater than or equal to the associated rate; and

a computer readable medium storing said computer code.

29. A computer program product for estimating worst-case queuing delay along a path in a packet switched network, said path comprising routers, the computer program product comprising:

computer code that causes a processor to collect burst and rate traffic parameters associated with a queue for each of a plurality of routers;

computer code that causes the processor to calculate a delay associated with the traffic parameters for said each of a plurality of routers by dividing the burst parameter by a share of output link bandwidth allotted to said queue, wherein the share of output link bandwidth is greater than or equal to the associated rate; and

computer code that causes the processor to add up the calculated delay associated with the routers along the path; and

a computer readable storage medium storing said code.

31. In a packet switched network, a method of estimating worst-case queuing delay along a path, said path comprising routers, the method comprising:

calculating periodic worst-case delay associated with a queue for each of a plurality of routers by dividing the burst parameter by a share of output link bandwidth allotted to said queue, wherein the share of output link bandwidth is greater than or equal to the associated rate;

periodically collecting periodic worst-case delay from said each of a plurality of routers; and

adding up the calculated periodic worst-case delay associated with the routers along the path.

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33. The method of claim 1 wherein calculating the burst-rate traffic profile comprises utilizing a token bucket.

34. The method of claim 33 wherein the token bucket size corresponds to a maximum burst rate.

35. The method of claim 33 wherein a replenishment rate of the token bucket is based on the associated rate.

36. The method of claim 1 wherein the burst parameter is calculated utilizing token buckets and the associated rate is set to a negotiated rate for a specified class of traffic.

37. The method of claim 1 wherein the associated rate is a maximum average bandwidth specified in a service level agreement.

38. The method of claim 1 wherein the burst-rate traffic profile comprises a y-intercept corresponding to the calculated burst parameter and a slope corresponding to the associated rate.

39. The method of claim 1 further comprising calculating a cumulative bandwidth profile having a slope equal to allocated bandwidth.

40. The method of claim 1 further comprising calculating error of data by comparing collected data to the burst-rate traffic profile.

41. The method of claim 40 further comprising calculating a new burst parameter if the error of data is higher than a predetermined limit.

42. The apparatus of claim 14 wherein code that causes the processor to calculate the burst-rate traffic profile comprises code that causes the processor to utilize a token bucket.

43. The apparatus of claim 42 wherein the token bucket size corresponds to a maximum burst rate.

44. The method of claim 9 wherein the burst parameter is calculated utilizing token buckets and the associated rate is set to a negotiated rate for a specified class of traffic.

45. The method of claim 9 wherein the rate parameter is a rate agreed to by a customer sending the traffic data.

46. The method of claim 11 further comprising calculating error of data by comparing collected data to the burst-rate traffic profile.

47. The apparatus of claim 23 wherein the burst-rate traffic profile comprises a y-intercept corresponding to the calculated burst parameter and a slope corresponding to the associated rate.

IX. EVIDENCE APPENDIX

None

X. RELATED PROCEEDINGS APPENDIX

None